Ministry of Natural Resources
Ontario

Northwestern Ontario Forest Technology Development Unit

1990/1991 ANNUAL REPORT

EXECUTIVE SUMMARY

The Northwestern Ontario Forest Technology Development Unit (NWOFTDU) has the mandate to improve timber and integrated resource management practices in northwestern Ontario by transferring relevant existing knowledge gained from research or field experience and by developing opportunities for integration of this new knowledge into operating activities. To achieve this objective, the NWOFTDU had an active program in the areas of technology management, technology transfer and development and demonstration projects during 1990/91.

As part of NWOFTDU's mandate, NWOFTDU staff ensure that information is received by field managers in a usable and understandable format. The effective use of existing knowledge and technology is referred to as technology management and consists of literature reviews and technical reports, technical notes, an old forestry trial inventory/data base and a library. A total of 19 literature reviews and technical reports were completed during 1990/91. Topics covered the spectrum of forest management issues including such items as preliminary variable density yield tables, comparative analysis of regeneration assessment techniques, small mammal and moose response to glyphosate tending and jack pine clumping. As part of the technical report series, the NWOFTDU entered into a partnership with Forestry Canada, Ontario Region and jointly published four COFRDA reports which were pertinent to our northwestern Ontario clients.

Five Technical Notes were produced during 1990/91. Technical Notes provide a practical summary of critical aspects of operational silviculture and habitat management as they apply to northwestern Ontario. Topics covered in 1990/91 included pre-commercial thinning, woodland caribou and competition index methodology.

Technology transfer is a key component of the NWOFTDU's program. The principle methods of delivery of the technology transfer program are via newsletters, workshops and extension services. Four issues of the NWOFTDU newsletter "On-Line" were published during 1990/91. The NWOFTDU field workshop series was extremely well received by NWOFTDU clients as indicated through the workshop evaluations. A total of fifteen workshop topics were covered during 1990/91 and included such topics as Forest Ecosystem Classification (FEC), vegetation management, caribou, lower cost regeneration options and pre-commercial thinning.

Development projects are intended to expand the technologies developed by researchers into useful field applications. Twenty-three on-going projects were worked upon in 1990/91. In

addition, fifteen new development projects were approved and initiated. These included in-growth of natural regeneration, bulk lifting and area-based planting, fisheries management videos and the development of a prime land key and algorithm for use with the Ontario Land Inventory (OLI).

The NWOFTDU had a budget allocation and expenditures of $1.1 million during 1990/91.

INTRODUCTION

This annual report will outline the achievements and expenditures of the Northwestern Ontario Forest Technology Development Unit (NWOFTDU) for the fiscal year 1990/91. These achievements and expenditures will be measured against those anticipated at the beginning of the fiscal year and outlined in the 1990/91 Work Plan.

Program achievements and project status in each of the following areas are highlighted: technology management, technology transfer, development and demonstration projects and administration.

1. TECHNOLOGY MANAGEMENT

As part of NWOFTDU's mandate, NWOFTDU staff ensure that information is received by field managers in a usable and understandable format. The effective use of existing knowledge and technology is referred to as technology management. The NWOFTDU's technology management program consists of a) literature reviews and technical reports; b) technical notes: c) an old trial inventory; and d) a library.

A) Literature Reviews and Technical Reports

A total of 19 literature reviews and technical reports were completed during 1990/91. Topics covered the spectrum of forest management issues including such items as preliminary variable density yield tables, comparative analysis of regeneration assessment techniques, small mammal and moose response to glyphosate tending and jack pine clumping.

As part of the technical report series, the NWOFTDU entered into a partnership with Forestry Canada, Ontario Region to jointly publish five (5) COFRDA reports which were pertinent to our northwestern Ontario clients. By fiscal year end, four of them were published:

- The autecology of major tree species in the north central region of Ontario;
- Common landform toposequences of northwestern Ontario;
- Stand and site conditions associated with the occurrence and distribution of black spruce advance growth in north central Ontario.
- Landform features in northwestern Ontario.

The fifth report, "Critical silvics of conifer crop species and selected competitive vegetation in northwestern Ontario" was still at the printers at fiscal year end.

This joint venture was very successful and produced a pertinent, high quality product for the NWOFTDU clients. Special thanks goes to Forestry Canada's staff involved in this project.

Total NWOFTDU expenditures on technology management during 1990/91 were $106.4 M (Table 1). As a comparison, the projected expenditures for technology management on the 1990/91 Work Plan was $106.0 M.

A listing of all the 1990/91 NWOFTDU publications can be found at the end of this report.

Table 1. NWOFTDU Technology Management and Technology Transfer Expenditures 1990/91 ($M).

	SALARIES	SUPPLIES/ SERVICE	TOTAL
A) TECHNOLOGY MANAGEMENT			
LITERATURE REVIEWS	26.8	.1	26.9
TECHNICAL REPORTS	1.8	40.8	42.6
TECHNICAL NOTES	0.1	3.0	3.1
OLD FORESTRY TRIAL INVENTORY	.7	.2	0.9
LIBRARY	30.6	2.3	32.9
SUB TOTALS	60.0	46.4	106.4
B) TECHNOLOGY TRANSFER			
EXTENSION SERVICES	26.0	18.3	44.3
NEWSLETTER	2.5	3.2	5.7
WORKSHOPS	19.8	30.3	50.1
SUB TOTALS	48.3	51.8	100.1
TOTALS	108.3	98.2	206.5

B) Technical Notes

Five Technical Notes were produced during 1990/91. NWOFTDU Technical Notes provide a practical summary of critical aspects of operational silviculture and habitat management as they apply to northwestern Ontario. The five Technical Notes that were produced during 1990/91 were:

- Pre-commercial thinning and mechanical cleaning: Multiple benefits from stand improvements (TN-06)

- Woodland caribou in northwestern Ontario: Why they are different (TN-07)

- Determining necessity and priority for tending in young spruce plantations in northwestern Ontario (TN-08)

- Black spruce site quality key for the northwestern region of Ontario (TN-09)

- A competition index methodology for northwestern Ontario (TN-10).

C) Old Forestry Trial Inventory

The old forestry trial inventory/library was completed in early 1990. Approximately 1,600 published and unpublished operational/research trials related to forest management in northwestern Ontario were assembled and entered into the old forestry trial Pro-Cite data base.

During 1990/91, an old forestry trial manual was completed and, along with the data base, was made available to NWOFTDU clients.

D) Library

The joint NWOFTDU/Ontario Forest Research Institute (OFRI) library moved to the new Centre for Northern Forest Ecosystem Research (CNFER) building on the campus of Lakehead University.

Much of the effort during 1990/91 was devoted to abstract production, and data entry, as well as moving the library. Approximately 10,216 abstracts and titles have been entered into the library data base.

An information searches workshop was held on November 23, 1990 to assist NWOFTDU clients in organizing and using library research techniques. Presentations from OMNR libraries, OFRI, and the NWOFTDU provided the participants with an understanding of the information services these groups offer. Pro-Cite, the computer software bibliographic reference tool used for the database, was featured at the workshop.

The library steering committee, which ensures that the objectives of the library are achieved, met twice during 1990/91.

A total of $32.9 M was spent by the NWOFTDU on the joint library in 1990/91 (Table 1).

2. TECHNOLOGY TRANSFER

Technology transfer is a key component of the NWOFTDU's program. The principle methods of delivering the technology transfer program are newsletters, workshops, and extension services.

A total of $100.1 M of a $88.0 M budget was spent on technology transfer during 1990/91.

A) Newsletter

Four issues of the NWOFTDU's newsletter "On-Line" were published during 1990/91. The newsletter featured and highlighted a number of pertinent topics/developments in resource management particularly in northwestern Ontario. These included:

- Introducing the Environmental Assessment Effects Monitoring Unit
- Landscape Ecology
- Electronic Data Collection
- Selective Harvesting in Areas of Concern

Although the number of articles submitted by NWOFTDU clients has increased slightly, most of the articles have still been prepared by NWOFTDU staff.

B) Workshops

The NWOFTDU field workshop series was extremely well received by NWOFTDU clients as indicated through the workshop evaluations.

The NWOFTDU hosted four FEC training workshops during 1990/91. These workshops were:

Basic Vegetation	June 20-22, 1990	Dryden
Basic Soils	June 25-28, 1990	Thunder Bay
Applied FEC	August 8-10, 1990	Atikokan
Soils and Landforms	September 25-28, 1990	Dryden

The first three FEC courses listed were instructed by NWOFTDU staff. The soils and landforms course was contracted to Geomatics International for delivery.

Eleven other workshop topics were covered during 1990/91. The following represent the workshops undertaken:

1. Introductory Applied FEC	May 31 - Geraldton September 26 - Ignace
2. Basic Vegetation Management	July 5 - Dryden July 27 - Kenora
3. Planning a Vegetation Management Strategy	September 24-25
4. Issues in Caribou Management	Sept. 10-11 - Armstrong Sept. 13-14 - Red Lake
5. Lower Cost Regeneration Options	Sept. 19-20
6. Pre-Commercial Thinning	Oct. 2-3
7. Prescribed Burning for Black Spruce	Oct. 10-11
8. Site Preparation in Residual Aspen and Aspen Re-Growth	Oct. 18
9. Aspen Management Quality Re-Visited	Oct. 23
10. Information Searches	Nov. 27
11. Electronic Data Collection	Nov. 28

A brochure outlining workshop contents was prepared and distributed to NWOFTDU's clients prior to the workshops.

The large annual workshops are no longer being offered by the NWOFTDU as per our review last year. Instead, these have been replaced by field workshops.

NWOFTDU Field Workshops usually have an indoor and outdoor component.

Expenditures on NWOFTDU workshops during 1990/91 amounted to $40.3 M. This included the cost of contract staff preparing and organizing material for the workshops, workshop speaker's costs, and costs associated with implementing the workshops (room, transportation, meals, etc.). An additional $9.8 M was spent on NWOFTDU staff attending and/or participating in other, outside workshops.

C) Extension Services

NWOFTDU staff specialists were involved in a wide range of extension activities during 1990/91. Much of these activities were focused upon providing information/knowledge requests or assisting in field problem solving. Examples of extension requests made to the NWOFTDU from our clients during 1990/91 included:

- planting on lowlands
- deep planting
- castle and cook mini-plugs
- herbicide rates, timing, and application
- vegetation management
- caribou biology
- pre-commercial thinning
- growth and yield information for managed plantations
- nutrient cycling.

Expenditures on NWOFTDU extension services amounted to $44.3 M.

3. DEVELOPMENT/DEMONSTRATION PROJECTS

A) On-going, Multi-year Projects

Twenty-three on-going projects were active during 1990/91 (Table 2). Many of these projects required field evaluation and data collection. A total of $182.0 M was spent on these on-going, multi-year projects.

These previously approved projects vary in their respective stages of development, with several being completed (Project numbers 44, 66, 67, 77, 79, and 82).

A summary of the status of each of these projects is provided.

Table 2. On-going, multi-year NWOFTDU projects 1990/91 ($M).

Project No.	Project Description	B Salary	TCSSE	Total
44	Herbicide Notes	0.9	-	0.9
46	Shelter Seeding	1.9	0.3	2.2
47	Overwinter Container Stock	0.4	-	0.4
49	Seeding Silts & Clay	0.1	-	0.1
53	Verification Sb Site Index	4.5	0.4	4.9
56	FEC	-	24.5	24.5
62	Sb Aerial Seeding	3.4	1.3	4.7
63	Site Qual. Eval. Handbook	7.1	11.5	18.6
65	Seed Preconditioning	8.9	0.3	9.2
66	Stand Dynamics in Clumped Pj	-	3.0	3.0
68	Bracke Seeding Trial	1.2	-	1.2
69	Further Dev. FEC Interpretations	-	5.4	5.4
70	Chemical SIP Trials	9.0	0.5	9.5
71	Mod. Cut/Moose Hunt Restrictions	5.0	19.3	24.3
72	Guide Appl. Mech. Site Pre.	11.6	11.4	23.0
73	Cntrl-Residual Poplar Regen.	4.4	1.1	5.5
74	Pw Management NWR/NCR	6.8	-	6.8
76	Heavy Soils Productivity	1.4	0.1	1.5
77	Crop Planning	-	5.8	5.8
78	Sb Regeneration Options	2.5	0.7	3.2
79	Stock Handling Guidelines	1.8	1.0	2.8
80	Cold Storage	14.2	1.0	15.2
82	Moose Habitat Primer	7.1	2.2	9.3
TOTALS		92.2	89.8	182.0

Project #41 Development of a 0 to 5 Year Pre- and Post-spray Competition Index

The objective of this project was to develop, field-test and market a comprehensive competition index assessment procedure which can be applied in conjunction with other operational regeneration surveys e.g. survival, fifth year stocking or Free-to-Grow assessments.

The project was completed in 1990/1991 with the completion of an MS-DOS data collection and analysis program configured for use with electronic data collection (EDC) terminals manufactured by DAP technologies. A guide to the use of the DAP program (TR#61) and Technical Note (TN-10) describing the biological basis and rational for the assessment procedure were completed and are currently available.

Competition index assessment procedure/program being used during the Vegetation Management Field Workshop.

Project #44 Preparation of a Pocket Guide to the Critical Silvics of Conifer Crop Species and Selected Vegetation in Northwestern Ontario.

Good vegetation management requires a thorough knowledge of ecological principles and successional trends. As well, the resource manager should be aware of the growth habits and ecological characteristics of individual competitors including their importance to wildlife management and their response to silvicultural treatment and stand disturbance.

The purpose of this project was to draw together practical information on the ecological characteristics of selected conifer and competitive species found in northwestern Ontario that will aid the resource manager in developing vegetation management strategies. Five coniferous crop species (black spruce, white spruce, jack pine, red pine and balsam fir) are reviewed in addition to 23 woody and herbaceous species which are potential competitors. The project involved a comprehensive literature review incorporating selected soil/site data from the NWO FEC data base.

Information from Project 44 being transferred during the Vegetation Management Field Workshop.

Over 500 references and abstracts relating to the project have been placed on a computer database ("Pro-Cite") and will be made available to interested parties.

This guide does not provide specific prescriptions for the control of competing vegetation, but will allow forest managers to develop site-specific vegetation management strategies on the basis of ecological and phenological information.

The camera ready copy is complete and awaiting publication as part of the joint NWOFTDU/ Forestry Canada COFRDA publication series.

Project #49 Aerial Seeding of Jack Pine on Silts and Clays

Jack pine can be effectively regenerated by aerial seeding in Ontario on coarser textured soils with exposed mineral soil. Finer textured soils on rich upland sites have traditionally been regenerated by planting. Demand for planting stock has recently outstripped supply and forced forest managers to examine other options for regenerating various sites.

In March of 1988, a five year cooperative project with Boise Cascade, Kenora, was initiated with a view to developing successful silvicultural techniques for aerial seeding of jack pine on fine-textured soils. Three separate trials are included in this project:

TRIAL #1 To document, monitor and evaluate the effectiveness of the spring 1988 operational aerial seeding of jack pine on heavy soils in the Pakwash Forest.

TRIAL #2 To monitor and evaluate the spring 1989 operational aerial seeding of jack pine on heavy soils in comparison to both planting and no regeneration treatments.

TRIAL #3 To compare fall 1988 seeding applied manually at four rates on heavy soils.

First year measurements of the 1989 spring seeding were done in May, 1990. Stocking, density and survival data will be recorded, analyzed and reported in interim reports. A final report on all three trials will be available as a Technical Report in March, 1995.

Project #62 Black Spruce Aerial Seeding

This is a cooperative trial with Red Lake District to test prescriptions (developed by Forestry Canada) for seeding black spruce on uplands in the Northwestern Region. In the fall of 1989, three replications of two site preparation treatments were applied to a fine-textured, Site Class 2 upland black spruce site. The areas were seeded to black spruce at a rate of 100,000 seeds per hectare in February of 1990.

Assessments in August of 1990 indicated an overall average stocking of 33.5% for seeded areas and 15.5% for control areas. Areas site prepared with drags had slightly higher stocking than those site prepared with a TTS trencher.

In February of 1991, a second seeding to black spruce at 100,000 seeds/hectare was carried out. Germination, stocking and microsite evaluation will be done in the fall of 1991 and 1994 with a final report being prepared in 1994.

Interim results were made available to clients in the newsletter.

Project #63 Guide to Site Quality Evaluation in Northwestern Ontario.

Soil and site conditions vary in their capacity to support the growth of the commercially important tree species. Wood quality is also directly affected by site conditions. Knowledge of these relationships and having a means of predicting anticipated yields will assist the forest manager in organizing and directing timber management activities.

The objectives of this project are to:

> Develop a field guide for the evaluation of site quality in northwestern Ontario.
>
> Communicate to field practitioners an understanding of species - site productivity relationships within the NWO FEC framework.

In 1990/1991, a tender was awarded to Dr. W.H. Carmean, School of Forestry, Lakehead University to write and edit the guide. To date the first five chapters have been submitted for review. The final report is due in August 1991 and will be printed in guidebook form by March 31, 1992.

Project #64 Jack Pine Seed Supply After Full-Tree and Tree-Length Logging

Tree-length logging (with crown and branch removal at the stump) has been a traditional method of regenerating dry to fresh jack pine sites in northwestern Ontario. Increasing use of full-tree harvesting, with complete removal of bole and crown to roadside, reduces slash loads and, hence, the number of cones left on-site to form the next crop. But what is the magnitude of this reduction?

Twenty-three cutovers formerly dominated by jack pine and harvested since 1985 were sampled in northwestern Ontario in 1989 for numbers and distribution of jack pine cones within 30 cm of ground level. Effects of stand age, harvesting season, harvesting method, and seedbed condition (with or without site preparation) were evaluated.

Harvesting older stands (>80 years) resulted in higher numbers of cones in cutovers compared to harvesting younger (<80 years) stands. Summer logging left more cones in the cutover than did winter logging. Tree-length harvesting tended to leave more cones behind in the cutovers than did full-tree harvesting, but there was no consistent trend. Site preparation following logging tended to reduce the number of cones in a cutover, regardless of harvesting season, harvesting method or stand age.

Final results will be published in a report by May 1991.

Project #65 Seed Pre-conditioning

A cooperative trial was initiated with C.P.F.P., Thunder Bay, to determine the effect of stratification (cool moist storage) on the survival and growth of jack pine and black spruce shelter seed versus bare seed. Seeds stratified for varying periods (0, 7, 15, and 30 days in 1989; 0, 7, and 15 days in 1990) were sown at monthly intervals from May to August in 1989 and three times through the summer in 1990.

Stratification increased the speed of germination but did not affect the percent stocked spots or the number of germinants per spot for either jack pine or black spruce in either year. Shelter cones reduced the numbers of seeds required and resulted in better germination, stocking and height growth for both species. May sown seedlings performed best with success decreasing as the season progressed.

Two-year-old black spruce seedlings from shelter seeding (Project 65).

Final assessments will be done on this trial in the fall of 1991 and a technical report will be published in 1992. Interim results were made available to clients through the newsletter.

Project #67 Development of a Technique for Interpreting FEC Information from Aerial Photography

The objective of this project is to develop a technique and methodology for reliably typing NWO FEC vegetation and soil conditions using aerial photography, and land resource inventory information supplemented by ground truthing.

The project was completed during 1990/1991 with the publication of NWOFTDU Technical Reports #54 and #49.

Project #68 Bracke Seeding Trial

In the fall of 1983, a trial was conducted north of Thunder Bay (Canadian Pacific Forest Products Limited's Camp 603) to test various Bracke seeding rates and scalp arrangements in relation to: i) operational efficiency; ii) germination success; and iii) resultant density and stocking of clumped versus free-growing trees over time.

Measurements were taken one and two years later, and final data were collected in the fall of 1988. A report by Roy Sidders, Red Lake District, OMNR will be available by May 1991.

Initial results indicated that recommended seeding rates varied with mattock arrangement, from a high of 20 seeds per scalp with scalps 2 x 2 m apart, to a low of five seeds per scalp when only 1 x 2 m apart.

Project #69 Updates to the Northwestern Ontario Forest Ecosystem Interpretations

Updates were produced for the Northwestern Ontario Forest Ecosystem Interpretations. These included prescribed burn opportunity, blowdown risk, root rot risk, soil limitations to the use of herbicides, and songbird habitat.

In addition, a new chapter covering pre-harvest surveys was completed along with an updated Literature Cited section.

These updates will be distributed automatically to those on the NWO FEC mailing list. Others are invited to request the updates from the NWOFTDU.

Project #70 Chemical Site Preparation

In cooperation with Abitibi-Price, Thunder Bay, and Dupont Canada Inc., a trial was set up to evaluate the effect of chemical site preparation using Vision, Velpar-L, Velpar-ULW and Pronone on survival and growth of jack pine and black spruce seed and container stock.

First year results indicate that Velpar-L was detrimental to seedling survival and seed germination. Seedlings and container stock on areas treated with Velpar-ULW did exceptionally well. Competition reduction was severe on all areas treated with hexazinone formulations.

Second year establishment will occur in 1991 and assessments will be completed in 1991, 1992, and 1993. An interim report on the trial was made available to clients in the newsletter.

Project #71 Moose Habitat and Hunting

The Sag-Mowe moose study evaluates several key intersections between timber harvest and hunting. The objective of the study is to provide sufficicent background data to permit recommendations on the optimum combination of control over timber and moose harvest.

Moose in the experimental area were subjected to hunting for the first time after a ten year no-hunt closure was lifted both on the guidelines-managed area and the non-guidelines-managed area. Hunters filled out a survey of where they hunted, saw or killed moose. An estimated 80 to 100 moose were harvested in a 4 week period. An aerial census of all 3 experimental blocks was completed in December 1990 and January 1991. No interim results are currently available.

The monitoring of hunter success, location of harvest and moose populations will be repeated in 1991/92.

Project #72 A Guide for the Application of Mechanical Site Preparation Equipment in Northwestern Ontario

A cooperative project was initiated with Forestry Canada - Ontario Region staff in 1989/1990 to prepare a field guide for the application of mechanical/chemical site preparation to northwestern Ontario sites, with an emphasis on understanding species' micro-site requirement and the biological and operational constraints to tree establishment and survival.

During 1990/1991, a review of literature dealing with mechanical site preparation in mid-temperate boreal forests was completed with emphasis on seedling growth response and site degradation/amelioration. Published information was supplemented by the development of a series of micro-site diagrams for different classes of disturbance and species - regeneration combinations based upon field staff expertise.

In order to develop the linkages with the NWO FEC treatment unit concept, a small field program was undertaken to sample representative site and stand conditions prior to site preparation. Fifty-four sites from across northwestern Ontario were sampled. Each of these same sites will be resampled in 1991/1992 to determine the effectiveness of the site preparation equipment in creating acceptable micro-site conditions. The final product of this phase of the project will be a pre-/post- site preparation photo-series for the guidebook.

During 1991/1992 interpretive keys and charts will be completed and verified through field inspection and consultations involving client and NWOFTDU staff. The post-SIP sampling will also be completed. A publication target date of 1991/92 remains in place.

Project #73 Control of Residual Poplar Re-growth on Former Jack Pine Dominated Sites in the Brightsands FMA

A cooperative trial with Canadian Pacific Forest Products was undertaken in 1989/1990 to evaluate post-harvest manual herbicide application methods for controlling aspen regrowth on sites scheduled to be seeded to jack pine. First-year post-treatment data was collected in 1990/91 and entered into the computer. In addition, permanent plot markers were installed on the three blocks and the treatment plots were restaked. The trial will be monitored and data collected on an annual basis until 1993/1994.

Project #74 White Pine Management in Northwestern Ontario

With recent concerns about logging in old growth pine stands, requests to increase the proportion of white pine in Quetico Park, and local shortfalls in white pine supply to sawmills, there was a need to reevaluate white pine management in northwestern Ontario.

An initiative was undertaken in 1989 to update and collate all the most recent information available about white pine management with relevance to northwestern Ontario conditions. Of particular interest were blister rust hazard ratings and zonation, growth and yield information by site type, the distribution of prime white pine site types across northwestern Ontario, methods of natural regeneration, age class distributions by forest, and seed availability from local or other sources.

A report is due in August 1991 and should provide the technical basis on which an active white pine management strategy for northwestern Ontario can be built.

Project #75 Gaspardo (Bartt) Seeder

Tests in 1988 showed that the Gaspardo (Bartt) seeder attachment for disc trencher type scarifiers was capable of singulating seed to prescribed levels. Some modifications were required to overcome practical problems which arose from the 1988 tests.

With these modifications in place, a trial was conducted in Dryden district in the summer of 1989 to determine: i) the operational efficiency of a fully functional unit; and ii) comparative seed germination rates, and stocking and densities between treated areas vs. natural ingrowth on control areas.

Second year data were collected in the fall of 1990. A final report is being written by Pat Corbett, Dryden District, OMNR and will be available by May 1991.

Project #76 Fine Soils Productivity in the Pakwash and Patricia Forests

In co-operation with Boise Cascade, Kenora, a study was undertaken in the fall of 1989 to investigate the timber growing capacity of the Pakwash and Patricia forests. Soils in this area are typically clayey, and little is known of their inherent site productivity, especially for jack pine and black spruce.

Over and above the sampling undertaken in 1989, an additional seven stands were sampled in 1990 and jack pine and black spruce stem-analyzed using the TRIM (Tree Ring Increment Measuring) system. Vegetation types were determined using the Forest Ecosystem Classification for Northwestern Ontario. Bulk C horizon samples were collected from each site and hand textured.

Growth data will be entered into a plantation growth model to compare species-specific managed stand growth and yield projections. A final report will be available by August 1991.

Project #78 Black Spruce Regeneration Options

This is a cooperative project with Boise Cascade (Kenora) and Kenora District to determine the most effective black spruce regeneration techniques on heavy soil sites in Red Lake and Kenora Districts. Survival and initial growth of natural regeneration, shelter seed, bare seed, and container stock are being compared.

First and second year assessments indicate that on all four areas in the Pakwash Forest as well as on the two sites in Kenora District, natural and bare seed black spruce stocking was less than 15%. Cerkon seed averaged 60% stocking in the Pakwash forest but less than 40% in Kenora District. Container stock survival ranged from 70 to 95% depending on the site.

This trial will be reassessed in 1993 and a technical report produced. Interim results were made available to clients via the newsletter.

Project #79 Stock Handling Guidelines

A user-friendly guide for field personnel was put together to both improve and standardize the approach to stock handling across northwestern Ontario. The guidelines cover all practices associated with bareroot and container stock handling from the nursery to the planting hole. Field input was solicited on a draft of the guidelines in the spring of 1990. The final version (TR#47) was published in the fall of 1990.

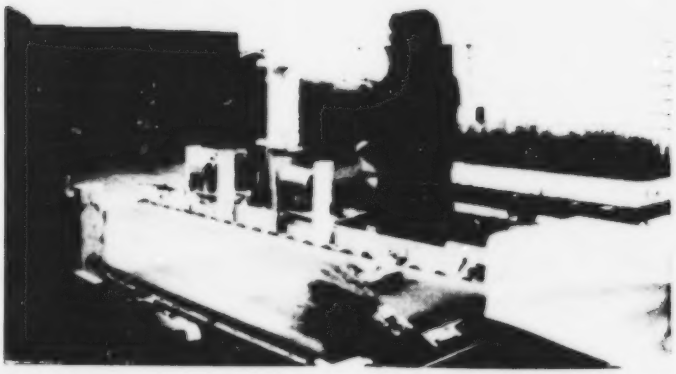
Project #80 Operational Cold Storage of Black Spruce Container Stock

A trial was initiated in 1989 to determine the feasibility of operational cold storage of container stock. The effects of frozen versus outdoor storage of black spruce paperpot and ventblock seedlings are being evaluated cooperatively with Abitibi-Price Inc. and C.P.F.P. Ltd., Thunder Bay, on three sites over three years.

In the first year, overwinter losses of outdoor stored stock ranged up to 25% of the trees per tray. Losses of frozen stored stock were negligible except for one group of ventblocks which sustained snowmould damage.

Cold storage did not impact on survival or growth of seedlings in the first year after outplanting.

An interim report on the project was made available to clients via the newsletter.



Container stock extraction for operational cold storage.

Project #82 Moose Habitat Interpretation In Ontario

This publication was produced in 1990/91 and is now available (TR#52). The manual describes important habitat components for moose and illustrates them with colour photographs. This manual is intended to increase the understanding of moose habitat by field managers responsible for applying the Timber Management Guidelines for the provision of Moose Habitat.

B) 1990/91 NEW DEVELOPMENT PROJECTS

As outlined in the 1990/91 Work Plan, fifteen new development projects were approved by the NWOFTDU Executive Committee (Table 3). Of these 15, one project (#84 - Fisheries Management Videos) was completed, with two other projects near completion (#85 - Prime Land Key and #95 - Bulk Lift/Area Based Planting). Project plans providing detailed information on objectives, rationale, methodologies, experimental design, budget and work schedule are on file at the NWOFTDU.

Expenditures on new development projects amounted to $231.2 M of the $250.4 M that was allocated.

A summary of the status of these 15 new 1990/91 development projects is provided.

Table 3. New NWOFTDU Development/Demonstration Projects, 1990/91 ($M).

Project No.	Project Title	B Salary	TCSSE	TOTAL
83	Ingrowth of Naturals	34.1	3.6	37.7
84	Fisheries Management Video	3.0	1.9	4.9
85	Prime Land Key	0.1	2.5	2.6
86	Leader Pruning Pj	4.0	0.7	4.7
87	Sb Growth, Nipigon	3.3	8.7	12.0
88	Aspen Soil/Site, NWR	47.5	16.9	64.4
89	Sb Regeneration on Lowlands	2.8	0.2	3.0
90	Spencer Lemaire C/S	0.1	0.3	0.4
91	Herbicide Ground Sprayer	19.6	7.3	26.9
92	Seasonal Suscep. to Vision	23.5	9.5	33.0
93	Sb Stock Type Demonstration	0.3	0.9	1.2
94	Estimation of Slope for TMP	9.8	1.6	11.4
95	Bulk Lift/Area-Based Planting	18.6	0.5	19.1
96	Tree Eggs	2.0	0.2	2.2
97	Pw Ecology & Silviculture	5.8	1.9	7 7
TOTALS		174.5	56.7	231.2

Project #83 Ingrowth of Naturals

Restrictions on the availability of planting stock, and the recent interest in crop planning have increased the urgency to obtain better information with regard to ingrowth (ingress) of natural regeneration. In particular, we need to be able to design regeneration prescriptions to maximize use of natural trees to reduce effort and dollars needed to achieve satisfactory stocking through artificial means.

We do not yet understand why some sites will have many volunteer stems after cutting and others very few, nor the rate of ingress of naturals onto sites. As a result, we currently cannot predict amounts and timing of ingrowth in relation to site and stand factors.

A study was initiated in 1990 with the following specific objectives:

> To investigate rates of ingress of naturals onto scarified and planted sites as affected by soil and vegetation type and seedbed condition.

To evaluate results in light of strategic crop planning and existing requirements for timing of regeneration surveys.

To evaluate the possibility of predicting post-harvest ingress rates of naturals from pre-cut stand and site features, and subsequent site preparation levels.

Approximately 50, ten- to fifteen-year-old plantations were sampled in North Central Region and 2500 trees stem-analyzed by the TRIM (Tree Ring Increment Measuring) system. Interim results from this first field season will be available in the fall of 1991. Similar sampling is planned for Northwestern Region during 1991. A final report will be written by April 1992.

Project #84 Fisheries Management Videos

The NWOFTDU converted the existing slide tape presentations, Fisheries Concerns with Water Crossings and Timber Management Effects on the Aquatic Environment into a video format. Fifty copies of each video were produced and NWOFTDU clients have been sent a copy. Other copies will be available for loan to non-clients.

Project #85 Prime Land Key and Algorithm for Use with the Ontario Land Inventory (O.L.I.)

Knowledge of species' soil-site relationships and the productive capacity of the landbase is an important consideration in making stand level regeneration prescriptions as well as in forest level crop planning. Keys for interpreting species'-site productivity based upon recognizable features of soils and landforms and mapped soil-site data are essential in advancing the application of the crop planning process.

In April 1990, a one year cooperative project with Boise Cascade (Fort Frances), Applied Science and Technology Section, OMNR, and Environment Canada (Sustainable Development Branch), was initiated. The objectives were:

To assess the usefulness of the NWO FEC productivity data as a basis for developing species' soil-site productivity relationships.

To construct primeland keys/lookup tables for each of the major commercial tree species based upon those criteria which can be interpreted from the Ontario Land Inventory - land type unit descriptions.

To develop the procedure for producing thematic/composite prime land maps for each of the major commercial species using the Ontario Land Inventory system.

Species' productivity and prime land 'lookup tables' were developed for black spruce, trembling aspen and jack pine in each of site regions 34/4400 and 53/43/3300 based upon NWO FEC productivity information and 'expert' opinion. Digitized Ontario Land Inventory coverage (ARC/INFO compatible) was also obtained from Environment Canada, Sustainable Development Branch.

The development of the prime land keys for interpreting the Ontario Land Inventory - land type unit maps (1:250 000) was completed during Fall 1991. A consultant was then hired to develop the ARC/INFO command files for assigning mapped soil data to prime land classes, producing polygon ledger summary reports and prime land summary reports.

Three O.L.I. test map sheet areas (Lake St. Joseph, Sioux Lookout and Wabigoon) were interpreted using the keys and algorithms and thematic prime land maps and summaries produced.

A technical note on the species' productivity 'lookup tables' and the prime land map data base will be available in the summer 1991. Prime land productivity maps and ledgers for the remainder of Northwestern Ontario will be produced in 1991/92.

Project #86 Jack Pine Leader Clipping

Pre-commercial thinning of young jack pine stands in northwestern Ontario is increasing. To date, brushsaws have been the primary instrument of choice. A recent study has shown that precision seeding techniques generally give rise to many seedlings growing very close to one another resulting in early stand structures that are noticeably clumped.

Concern has arisen that brushsaws may result in a large amount of residual crop tree damage when trying to remove unwanted trees from a tight clump. Leader pruning (clipping) has been suggested as a possible alternative to brushsaws for releasing crop trees in young, clumped stands.

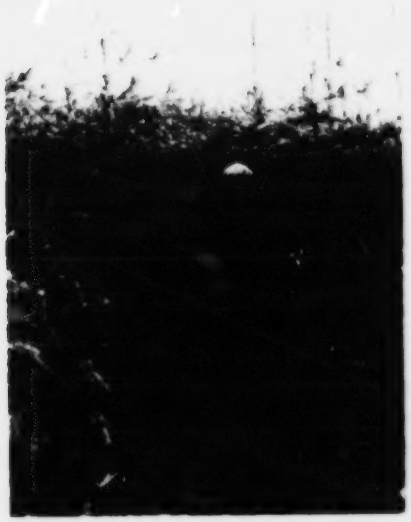
In 1990, a project was initiated with the following specific objectives:

> To determine if leader pruning clustered jack pine is a viable option when compared to brushsaw pre-commercial thinning in terms of growth response of crop trees and operational efficiency.
>
> To compare the above in a stand with a high density, moderate clumping index to a stand with a low density, high clumping index.
>
> To evaluate treatment effects on stand-level changes such as species composition and diameter distribution.

A field trial was established in October 1990 north of Vermilion Bay, and some preliminary findings were reported in the Winter 1991 issue of ON-LINE. The second trial is scheduled to be established in the Sioux Lookout area during the summer of 1991.

Interim reports will be available by March 1992. A final report will be written by March 1995.

Jack pine leader clipping; a viable alternative to brush saws?



Project #87 Growth of Plantation Black Spruce in the Lake Nipigon Area

The purpose of this project was to provide an update on the growth of plantations in the Lake Nipigon area, which were previously reported as exceeding normal yield tables, to provide baseline information on how well managed stands could perform.

The project was contracted to the University of Guelph with support and cooperation from both Nipigon District and the NWOFTDU.

A technical report will be available in the summer of 1991.

Project #88 Verification of Trembling Aspen Soil-Site Relationships for Northwestern Ontario

Trembling aspen is the most widely distributed tree species in northwestern Ontario. It occupies a broad range of soil and climatic conditions and varies with respect to growth, yield and the occurrence of cull. In April 1991 a cooperative project with Forest Measurements and Modelling Section, OMNR, was initiated with the following objectives:

> To verify the application of polymorphic site index curves developed for trembling aspen in north central Ontario to the species growing in northwestern Ontario.
>
> To determine soil/site productivity and cull relationships for trembling aspen in northwestern Ontario and to relate the productivity estimates to the Northwestern Ontario Forest Ecosystem Classification system.

Sixty-four fully stocked stands of trembling aspen no younger than 50 years of age were sampled across a range of soil conditions in northwestern Ontario in 1990. Five trees, one from each diameter class, were destructively sampled and scaled for cull and defect; two of the trees were returned to Thunder Bay for stem analysis. The stem analyses and soil analysis were then completed during the winter of 1990/1991.

Data analysis completed during early summer 1991 will provide the basis for a technical note/ report to be published later in 1991/1992. The results from this project will be included in the 'Guide to Estimating Site Quality' handbook (Project 63).

Project #89 Black Spruce Regeneration on Lowland Sites in Northwestern Region

A cooperative project with Boise Cascade, Kenora to examine the influence of blading versus no site preparation on initial survival and growth of black spruce bare seed, shelter seed and container stock was initiated in 1990.

Three sites were chosen in 1990 but the site preparation could not be completed. This project has been delayed until 1991/92.

Project #90 Medium Stock Container Trial

Originally entitled, Spencer-Lemaire Stock Trial, this project was cancelled in May 1990 due to severe winterkill of the stock.

A province-wide medium stock trial has recently been initiated with objectives that overlap to a great extent with those of Project #90. As a result, this project has been refocussed and the role of the NWOFTDU will be one of advising on site selection for those areas within NWOFTDU jurisdiction participating in the province-wide trial.

Project #91 Herbicide Ground Application Project - Nipigon District

Ground herbicide application for tending/release and chemical site preparation activities have increased dramatically in northwestern Ontario over the last several years. Many of these activities occur on small, highly dispersed regenerating cutovers less than 10 hectares in size which cannot be treated efficiently using conventional aerial application technology. Unfortunately, only a limited number of ground application technologies are currently available to boreal forest managers.

In cooperation with Nipigon District and Forest Health and Protection Section, OMNR, a five-year ground release trial was established in 1991 with the following objectives:

> To document the equipment and application procedures available for ground release treatment of young black spruce and jack pine plantations.
>
> To describe the short term (0 to 3 year) growth response of planted black spruce and jack pine following release using several different ground application technologies.
>
> To describe the short term (0 to 3 year) change in the amount and type of non-crop vegetation following conifer release using several different ground application technologies.

Two sites were established representing differences in the nature of the competing vegetation. Site 1 supported vigourous growth of trembling aspen, wild raspberry and bluejoint grass. Treatments installed in 1990 included a control, E-Z-Ject application of Vision, thin line application of Triclopyr (Release), Backpack application of Vision using a waving wand, broadcast brush saw with Enso attachment application of Vision to the cut stump, broadcast brush saw application and complete removal of all competing vegetation using herbicides. In 1991 a further treatment -- reel and hose spot application of Vision -- will be installed providing a contractor can be found.

Site 2 supported alder, bluejoint grass and raspberry. Treatments installed in 1991 included control, reel and hose application of Vision using a waving wand, spotgun application of Velpar and complete removal of all competing vegetation using herbicides.

First year pre- and post-treatment measurements were done in 1990. An interim report to be available in October 1991 will be prepared following the second-year assessments in July 1991. A final report on both trials will be available as a technical report in March 1995.

Ground herbicide application, Nipigon District

Project #92 Seasonal Susceptibility of Five Competitive Species Found in Northwestern Ontario to Vision

Non-crop species often vary in their susceptibility to herbicides depending upon their stage of development (phenology) and physiological status. A cooperative trial was established in 1991 with Nipigon District, OMNR; Boise Cascade, Fort Frances; Abitibi-Price, Thunder Bay and Monsanto Canada. The objective of this project was:

> To demonstrate and document seasonal changes in the susceptibility of black spruce, jack pine, trembling aspen, mountain maple, beaked hazel, raspberry and Canada bluejoint to the herbicide Vision applied at five different application times and at two different rates.

Three test sites were established (Nipigon C.M.U., Abitibi-Price Block #3 and the Seine River F.M.A.). A total of 39 plots were established at each location representing the 12 different rate X time combinations. The Northwestern Ontario Competition Index procedure was used to monitor changes in the competing species.

This trial will be assessed in 1991, 1992 and 1993 to determine degree of control and regrowth potential of the species at the different rate X time combinations. Final results will be published in Fall-Winter 1993.

Project #93 Black Spruce Stock Type Comparisons

The purpose of this project is to establish demonstration areas for black spruce stock type comparisons on high, medium, and low productivity sites and to demonstrate the effectiveness of early release on the stock.

In 1990, two districts were approached for planting sites and the availability of the stock types was ensured. The demonstration areas will be planted in 1991.

Project #94 Estimation of Slopes for Timber Management Planning

Slope estimation methods used for determining riparian buffer strips were compared. Extensive variation was observed both among and within methods. Most of the within-method variation was attributable to different users. Results indicate greater training and standardization of methods is required for repeatable results.

A Technical Report will be produced in the fall of 1991.

Project #95 Bulk Lift - Area Based Planting

An economic evaluation of a combined bulk lift and area based plant was completed. Bulk lifting in tree nurseries is economically viable if nursery stock is uniform, with a low cull percentage. Total cost savings of 29% are expected. Capital costs were not included in the analysis. Potential problems with displacement of nursery soil and potential increased costs of shipping and field handling were identified. No savings are expected from area based planting on large clear cut areas with little residual. Cost savings are expected from area based planting if extensive residual or advance growth is present or if availability of plantable spots is highly variable.

Bulk lifting is compatible with area based planting, but not with conventional by-the-tree planting. A technical report will be available by July 1991.

Project #96 Dupont Tree Eggs

A cooperative project with Dupont Canada, this trial set out to evaluate black spruce and jack pine regeneration using Dupont's tree eggs as compared with shelter seeding.

Tree eggs containing one or three seeds were sown into holes or on the surface in May and June of 1990. Cerkons were sown with one and three seeds for comparison.

First year assessments indicated jack pine tree eggs averaged less than 25% stocked spots whereas cerkons averaged greater than 80%. Black spruce tree eggs averaged less than 5% stocked spots whereas cerkons averaged 40% for one seed and 80% where three seeds were sown.

Recommendations were made to Dupont Canada on possible modifications to make the eggs more successful. Results of the project were made available to clients via the newsletter. A technical note will be produced following second year assessments.

Project #97 White Pine Regeneration

In the first year of this project to establish demonstrations of white pine regeneration methods in northwestern Ontario, much of the preliminary background work was accomplished.

A field trip to Algonquin and Northeastern regions identified several regeneration techniques which may have merit in northwestern Ontario. In addition, preliminary evaluations of unassisted natural regeneration were completed.

White pine management in northwestern Ontario; we need to get active.

Currently, several locations are being sought to establish white pine regeneration demonstration areas.

C) OTHER PROJECTS ADMINISTERED BY NWOFTDU

Two other projects were administered by the NWOFTDU during 1990/91 using other funding sources. These two projects were the aerial application of Velpar-L on sandy loam soil for conifer release and caribou habitat supply. Details on the two projects are found below.

Aerial Application of Velpar-L on a Sandy Loam Soil for Conifer Release

A liquid formulation of hexazinone (Velpar-L) was aerially-applied on coarse loamy soil as chemical site preparation for conifer species near Raith, Ontario in 1987. The objectives of this study were: i) to monitor short- and long-term response of crop trees and target species as well as shifts in vegetation composition; and ii) to investigate correlations between treatment efficacy and soil types.

In 1990/91 Forest Health and Protection Section and the NWOFTDU reassessed the trial installation and decided to continue crop and vegetation assessments until 1991/92. In 1990/91 crop trees were remeasured and data entered into the computer. A final report will be forthcoming in 1991/92.

Caribou Habitat Supply

Work on caribou habitat supply was a special project undertaken to meet an immediate need in northwestern Ontario.

An overview of caribou habitat supply was generated and mapped for portions of Sioux Lookout, Ignace, Thunder Bay, and Nipigon Districts. These maps were used to strategically identify areas which should be given special consideration in the short-term until the caribou policy and guidelines are approved, and we can specifically define the management practices required for caribou.

4. CORE PROGRAM/ADMINISTRATION

A) Staffing

During 1990/ 91, a number of acting assignments were still in effect. Bill Baker was still acting Manager, NWOFTDU replacing Al Willcocks (who was acting District Manager, Thunder Bay District). Lisa Buse was acting Black Spruce Program Forester on a training and development assignment.

The NWOFTDU staff at the end of 1990/91 consisted of:

Permanent (Classified) Staff

Bill Baker, Manager (Acting)
Bill Towill, Mixedwood Program Forester
Colin Bowling, Pine Program Forester (Kenora)
Gerry Racey, Integrated Resources Management Specialist
Nancy Knudsen, Administrative Officer

Contract Staff (Unclassified)

Professional Staff

Lisa Buse, Black Spruce Program Forester (Acting)
Glen Niznowski, Pine Project Forester (Kenora)
Wayne Bell, Special Projects Forester
Laura Scott, Systems Officer (shared position with Thunder Bay Forest Nursery)

Technical Staff

Tim Cavanagh, Resource Technician
Mark Roddick, Resource Technician

Clerical Staff

Karen Caruk, Administrative Clerk
Alanna Warren-Daze, Clerical Assistant

In addition, a number of technical and professional contract non-recurring staff were hired to work on specific NWOFTDU projects.

Staff at the Thunder Bay Office can be contacted at (807) 939-2501, FAX: (807) 939-1918. The Kenora based staff can be reached at (807) 468-2650 or 468-2500, FAX: (807) 468-2737.

B) Administration

The cost of day-to-day operations of the NWOFTDU (ie keeping the door open, permanent staff salary, clerical assistance, vehicles, etc.) amounted to $489.3 M (Table 4). These support and administration costs were lower than the allocation outlined in the Work Plan ($538.0 M). This was due to prepayment of some vehicle costs in 1989/90 and external funding of employee benefits.

C) Budget

The NWOFTDU had expenditures of $1.164 million during 1990/91 (Table 5) from a budget of $1.167 million. This budget was somewhat higher than the $1.140 million outlined in the 1990/91 Work Plan, due in part to previous 1989/90 fiscal year expenses ($54.7) being held corporately until the 1990/91 fiscal year.

Table 6 provides a summary of the various funding sources. This was the last year of the five-year funding agreement with the Ministry of Northern Development and Mines (MNDM). Funding from MNDM was instrumental in establishing the NWOFTDU. Funds for development and demonstration projects ($512 M) was secured through the forest management program of Northwestern and North Central regions. As part of the project #88 on aspen soil/site relationships, the Forest Measurements and Modelling Section of Forest Resources Group allocated $15.0 M. In addition, most of NWOFTDU clients contributed 'in kind' to many of the NWOFTDU undertakings, and these contributions were greatly appreciated.

Expenditures for the NWOFTDU by the major program areas are outlined in Table 5, and compared with those in the Work Plan. Overall, the expenditures for 1990/91 were similar to the initial allocation.

Program delivery (excluding the core program and previous fiscal year expenses) resulted in 17% technology management, 16% technology transfer, 29% multi-year projects, and 37% for new development projects.

Table 4. Core Program/Administration Costs for 1990/91 ($M)

	Salaries	Supplies/ Services	Total
Salaries (Permanent Staff)	295.6	-	295.6
Clerk/Typists Salaries	49.8	0.7	50.5
Travel/Vehicles	15.9	13.5	29.4
Telephone/Hydro/Heat		20.0	20.0
Office Supplies/Equipment/Copying		26.1	26.1
Building Maintenance/Renovations		4.9	4.9
Committee Expenses		2.7	2.7
Systems	19.0	17.8	36.8
Staff Training	12.9	10.4	23.3
TOTALS	393.2	96.1	489.3

Table 5. 1990/91 NWOFTDU Expenditure Summary ($M). Numbers in parenthesis represent the allotment as identified in the 1990/91 NWOFTDU Work Plan.

	A-Salary	B-Salary	TCSSE	Total
Previous FY (Expenses)			54.7 (0)	54.7 (0)
Core Program	295.6 (265.0)	97.6 (80.0)	96.1 (193.0)	489.3 (538.0)
Technology Management		60.0 (61.0)	46.4 (45.0)	106.4 (106.0)
Technology Transfer		48.3 (37.0)	51.8 (51.0)	100.1 (88.0)
Development/Demonstration On-going, Multi-year Projects		92.2 (89.2)	89.8 (68.4)	182.0 (157.6)
1990/91 New Projects		174.5 (177.0)	56.7 (73.4)	231.2 (250.4)
TOTAL	295.6 (265.0)	472.6 (444.2)	395.5 (430.8)	1,163.7 (1,140.0)

Table 6. Funding sources for 1990/91 NWOFTDU expenditures ($M).

Source	A-Salary	B-Salary	TCSSE	Total
MNDM	275.0	362.8	2.1	639.9
MNR - NWR		40.0	125.4	165.4
MNR - NCR		89.1	257.5	346.6
MNR - Forest Resources			15.0	15.0
TOTALS	275.0	491.9	400.0	1,166.9.0

1990/91 NWOFTDU PUBLICATIONS

STAND AND SITE CONDITIONS ASSOCIATED WITH THE OCCURRENCE AND DISTRIBUTION OF BLACK SPRUCE ADVANCED GROWTH IN NORTH CENTRAL ONTARIO. 1991. S.A. Walsh and G.M. Wickware. TR#24.

TO GROW OR NOT TO GROW, STOCK HANDLING GUIDELINES FOR NORTH-WESTERN ONTARIO. 1990. L.J. Buse and W.D. Baker. TR#47.

THE AUTECOLOGY OF MAJOR TREE SPECIES IN THE NORTH CENTRAL REGION OF ONTARIO. 1990. R.A. Sims, H.M. Kershaw and G.M. Wickware. TR#48.

COMMON TOPOSEQUENCES OF NORTHWESTERN ONTARIO. 1990. K.A. Baldwin, J.A. Johnson, R.A. Sims and G.M. Wickware. TR#49.

PRELIMINARY VARIABLE DENSITY YIELD TABLES FOR NORTHWESTERN ONTARIO CONIFERS. 1990. F.W. Bell, A.J. Willcocks, and J. Kavanagh. TR#50.

COMPARATIVE ANALYSIS OF REGENERATION ASSESSMENT TECHNIQUES - A LITERATURE REVIEW. 1989. M. Corbett and L. McCulligh. TR#51.

MOOSE HABITAT INTERPRETATION IN ONTARIO. 1991. G.L. Jackson, G.D. Racey, J.G. McNicol and L.A. Godwin. TR#52.

NON-SPRAY SPRUCE BUDWORM MANAGEMENT ALTERNATIVES: WILL THINNING SECOND-GROWTH BALSAM FIR IN NORTHWESTERN ONTARIO ALTER THE STANDS' VULNERABILITY TO SPRUCE BUDWORM DAMAGE? 1990. W.M. Van Schip, T. Zago and W.D. Towill. TR#53.

PHOTO INTERPRETATIONS OF THE NWO FEC VEGETATION AND SOIL TYPES FOR THE AULNEAU PENINSULA: NORTHWESTERN ONTARIO. 1989. G.M. Wickware and Associates. TR#54.

THE NORTHWESTERN ONTARIO FOREST ECOSYSTEM CLASSIFICATION AS A DESCRIPTOR OF WOODLAND CARIBOU (*RANGIFER TARANDUS CARIBOU)* RANGE. 1990. P.R. Morash and G.D. Racey. TR#55.

WINTER UTILIZATION BY MOOSE OF GLYPHOSATE-TREATED CUTOVERS. 1990. J.F. Connor and L.M. McMillan. TR#56.

SMALL MAMMAL AND LESSER VEGETATION RESPONSE TO GLYPHOSATE TENDING IN NORTH CENTRAL ONTARIO. 1990. L.M. McMillan, J.F. Connor, H.R. Timmermann, J.G. McNicol and C.S. Krishka. TR#57.

THE EXTENT AND NATURE OF SEEDED JACK PINE CLUMPING FOLLOWING DISTURBANCE IN NORTHWESTERN ONTARIO. 1990. L.Van Damme and K. McKee. TR#58.

EVALUATION OF STAND VULNERABILITY TO SPRUCE BUDWORM ATTACK USING GIS. 1990. G.M. Wickware and R.A. Sims. TR#59.

LANDFORM FEATURES IN NORTHWESTERN ONTARIO. 1991. R.A. Sims and K.A. Baldwin. TR#60.

COMPETITION INDEX PROGRAM USER'S MANUAL. 1991. L. Scott, W.D. Towill and G. Edgar. TR#61.

PRECOMMERCIAL THINNING AND MECHANICAL CLEANING: MULTIPLE BENEFITS FROM STAND IMPROVEMENT. 1990. G.D. Racey and M. Pletch. TN#06.

WOODLAND CARIBOU IN NORTHWESTERN ONTARIO: WHY THEY ARE DIFFERENT... 1990. L. Godwin. TN#07.

DETERMINING NECESSITY AND PRIORITY FOR TENDING IN YOUNG SPRUCE PLANTATIONS IN NORTHWESTERN ONTARIO. 1991. L.J. Buse and W.D. Baker. TN#08.

BLACK SPRUCE SITE QUALITY KEY FOR THE NORTHWESTERN REGION OF ONTARIO. 1991. L.J. Buse and W.D. Baker. TN#09.

A COMPETITION INDEX METHODOLOGY FOR NORTHWESTERN ONTARIO. 1991. W.D. Towill and D.A. Archibald. TN#10.

NORTHWESTERN ONTARIO FOREST TECHNOLOGY DEVELOPMENT UNIT 1991/92 WORK PLAN. 1991.

TOOLS FOR SITE SPECIFIC SILVICULTURE IN NORTHWESTERN ONTARIO. 1990. A.J. Willcocks, W.D. Baker, L. Sumi, and W. Carmean. Technical Workshop Report #03.

POTENTIAL REPSONSES OF MARTIN HABITAT CARRYING CAPACITY TO FUTURE TIMBER HARVESTS IN A NORTHERN ONTARIO FOREST. 1990. M. Martelle. Miscellaneous Report #06.

VIDEOS

EFFECTS OF TIMBER MANAGEMENT ACTIVITIES ON THE AQUATIC ENVIRONMENT. 1991.

FISHERIES CONCERNS WITH WATER CROSSINGS. 1991.

Copies available from:
Ontario Ministry of Natural Resources
Northwestern Ontario Forest Technology Development Unit
R.R. #1, 25th Side Road, Thunder Bay, Ontario P7C 4T9
Telephone: (807) 939-2501

4665
ISSN 1180-2952